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# STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT

## AIR QUALITY AND EMISSIONS PANEL REPORT NO. 3

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16. Abstract

This Air Quality and Emissions Panel Report is No. 3 of a group of seven (7) prepared by special panels of the Task Force established under the joint chairmanship of DOT and EPA to conduct a study of the practicability of a fuel economy improvement standard of 20% for new motor vehicles produced in the 1980 time frame.

The report describes the factors which effect air quality, i.e., number and kind of stationary emission sources, the motor vehicle fleet mix and number of vehicle miles traveled by each class of vehicle, etc.; and then by using a simple methodology described in the test, draws some conculsions on the effect various fuel economy strategies will have on air quality.

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## PREFACE

This Air Quality and Emissions Panel Report is No. 3 of a group of seven (7) prepared by special panels of the Task Force established under the joint chairmanship of DOT and EPA to conduct a study of the practicability of a fuel economy improvement standard of 20% for new motor vehicles produced in the 1980 time frame. Each panel addressed a major impact area and drew on a variety of sources in preparing its report, including previous DOT and EPA research, and industry and public comments.

Materials developed by the various study panels were used in preparing the Report to Congress entitled "Potential for Motor Vehicle Fuel Economy Improvement", dated 24 October 1974 (second printing, 18 November 1974). Assumptions and conclusions expressed in the panel reports, however, are those of the respective panels and do not necessarily reflect official positions or policies of the U.S. Department of Transportation, the U.S. Environmental Protection Agency, or the study Task Force.

The complete Panel Reports set consists of the following:

Report No. 1: Policy Assessment Panel Report
Report No. 2: Safety Implications Panel Report
Report No. 3: Air Quality and Emissions Panel Report
Report No. 4: Technology Panel Report
Report No. 5: Economics Panel Report
Report No. 6: Fuel Economy Test Procedures Panel Report
Report No. 7: Truck and Bus Panel Report

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# 1. INTRODUCTION

This Air Quality and Emissions Panel report of the joint U.S. Environmental Protection Agency (EPA) - U.S. Department of Transportation (DOT) 120 - Day Fuel Economy Study is one of sevel panel reports submitted to the Study Task Force: Mr. Eric Stork, EPA; Dr. R.E. Goodson, DOT; and the representatives of the Treasury Department; The Federal Energy Agency and the Council of Environmental Quality.

The authors, using a simple methodology described in the first part of the text, draw some conclusions on the effect various fuel economy strategies will have on air quality.

# 2. SUMMARY AND CONCLUSION

## 2.1 SUMMARY

Air quality is dependent upon a number of factors including the number and kind of stationary emission sources, the motor vehicle mix (age, relative abundance of diesel trucks, gasoline powered trucks, light duty vehicles) and number of vehicle miles traveled by each class of vehicle, the degree of emission control on mobile and stationary source emitters, altitude, and climatic and meteorological conditions.

Three categories of emissions are currently controlled for all highway vehicles except motorcycles. Emission standards for hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen ($NO_x$), are currently promulgated for each class of controlled vehicle. Heavy duty diesel engines operated on the highway are also subject to a smoke standard.

Mobile sources are responsible for approximately 55% of the HC, 77% of the CO, and 51% of the $NO_x$ emitted nationally in 1971. However, since air pollution is not uniformly distributed throughout the nation it is logical to discuss the impact of motor vehicle emission reduction on the total emissions or air quality of specific metropolitan areas.

Table 1 shows the percent contribution of seven source categories to total regional emission of non-methane hydrocarbons (NMHC) in ten regions and a "composite" region. Note that the expected control of mobile source NMHC emissions results in a decrease in the percent contribution of mobile sources to less than 10 percent of the total by 1990.

Table 2 is similar to Table 1 except that $NO_x$ is the subject. Table 2 is based on the assumption that the Light Duty Vehicle (LDV) emission standard for $NO_x$ will remain at 2.0 grams per mile (gpm) through 1990. This is only a working assumption, not a prediction or recommendation. The effect of an $NO_x$ standard of 0.4 gpm applied before 1990 may be estimated using material presented later in

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TABLE 1. PROJECTED PERCENT EMISSIONS CONTRIBUTIONS FOR HC (For Assumptions and Calculation Methods see Appendicies 1-5)

| City | Year | LDV | LDT | HDG | HDD | Other | G Evap | SS |
|---|---|---|---|---|---|---|---|---|
| Las Vegas | 70 | 48 | 7 | 7 | 0 | 19 | 7 | 11 |
| | 75 | 35 | 6 | 6 | 0 | 28 | 11 | 15 |
| | 80 | 20 | 3 | 3 | 0 | 47 | 3 | 23 |
| | 85 | 10 | 2 | 2 | 0 | 61 | 4 | 22 |
| | 90 | 7 | 1 | 1 | 0 | 64 | 4 | 23 |
| Los Angeles | 70 | 48 | 8 | 3 | 1 | 6 | 5 | 29 |
| | 75 | 35 | 6 | 3 | 1 | 9 | 7 | 39 |
| | 80 | 20 | 3 | 2 | 1 | 15 | 2 | 56 |
| | 85 | 10 | 2 | 1 | 1 | 21 | 3 | 62 |
| | 90 | 7 | 1 | 1 | 1 | 23 | 3 | 65 |
| Sacramento | 70 | 35 | 10 | 5 | 1 | 12 | 5 | 23 |
| | 75 | 52 | 7 | 4 | 1 | 18 | 7 | 31 |
| | 80 | 18 | 3 | 3 | 1 | 29 | 2 | 43 |
| | 85 | 9 | 2 | 1 | 1 | 39 | 3 | 45 |
| | 90 | 6 | 2 | 1 | 1 | 41 | 3 | 47 |
| San Diego | 70 | 35 | 10 | 5 | 1 | 9 | 4 | 29 |
| | 75 | 51 | 7 | 4 | 1 | 13 | 6 | 39 |
| | 80 | 17 | 3 | 3 | 1 | 21 | 2 | 53 |
| | 85 | 9 | 2 | 1 | 1 | 29 | 2 | 57 |
| | 90 | 6 | 2 | 1 | 1 | 30 | 2 | 59 |
| San Francisco | 70 | 45 | 10 | 4 | 1 | 8 | 5 | 27 |
| | 75 | 33 | 7 | 4 | 1 | 12 | 7 | 37 |
| | 80 | 18 | 3 | 2 | 1 | 20 | 2 | 52 |
| | 85 | 9 | 2 | 1 | 1 | 28 | 3 | 56 |
| | 90 | 7 | 2 | 1 | 1 | 29 | 3 | 59 |
| S.L. Desert | 70 | 51 | 11 | 5 | 1 | 9 | 6 | 17 |
| | 75 | 30 | 9 | 5 | 1 | 14 | 8 | 25 |
| | 80 | 24 | 6 | 4 | 1 | 25 | 3 | 39 |
| | 85 | 12 | 3 | 2 | 1 | 35 | 4 | 43 |
| | 90 | 9 | 2 | 1 | 1 | 38 | 4 | 45 |
| Denver | 70 | 51 | 11 | 10 | 1 | 5 | 5 | 18 |
| | 75 | 30 | 9 | 9 | 1 | 8 | 8 | 27 |
| | 80 | 25 | 6 | 7 | 1 | 15 | 3 | 44 |
| | 85 | 14 | 3 | 3 | 1 | 32 | 4 | 52 |
| | 90 | 11 | 2 | 2 | 1 | 33 | 4 | 56 |
| New York City | 70 | 35 | 9 | 3 | 0 | 2 | 4 | 38 |
| | 75 | 51 | 7 | 2 | 0 | 3 | 6 | 31 |
| | 80 | 17 | 4 | 1 | 0 | 6 | 2 | 71 |
| | 85 | 9 | 2 | 1 | 0 | 8 | 2 | 78 |
| | 90 | 6 | 1 | 0 | 0 | 9 | 2 | 81 |
| Boston | 70 | 35 | 9 | 4 | 0 | 2 | 4 | 31 |
| | 75 | 37 | 7 | 4 | 1 | 3 | 6 | 33 |
| | 80 | 22 | 4 | 3 | 1 | 5 | 2 | 54 |
| | 85 | 12 | 3 | 1 | 1 | 7 | 3 | 74 |
| | 90 | 9 | 2 | 1 | 0 | 7 | 3 | 78 |
| Dayton | 70 | 52 | 11 | 5 | 1 | 9 | 5 | 16 |
| | 75 | 30 | 8 | 5 | 2 | 13 | 8 | 26 |
| | 80 | 23 | 5 | 2 | 2 | 26 | 3 | 40 |
| | 85 | 12 | 3 | 1 | 1 | 36 | 4 | 44 |
| | 90 | 9 | 2 | 1 | 1 | 38 | 4 | 46 |
| Composite | 70 | 36 | 9 | 4 | 1 | 5 | 5 | 31 |
| | 75 | 55 | 7 | 3 | 1 | 8 | 6 | 42 |
| | 80 | 19 | 4 | 2 | 1 | 13 | 2 | 60 |
| | 85 | 10 | 2 | 1 | 1 | 18 | 3 | 66 |
| | 90 | 7 | 2 | 1 | 1 | 19 | 3 | 69 |

Source Categories

Sources of CO, $NO_x$ and NMHC are divided into the following categories:

LDV - light-duty vehicles - 0-6000 lb. GVW
LDT - light duty trucks - 0-8500 lb. GVW
HDG - heavy duty gasoline vehicles - > 8500 lb. GVW
HDD - heavy-duty diesel vehicles - > 8500 lb. GVW
GE - gasoline evaporation from fuel transfer (NMHC only)
Misc - Miscellaneous mobile sources
SS - stationary sources

The letters "GVW" stand for gross vehicle weight; this is the vehicle weight at rated load. The LDT category presently covers trucks up to 6000 lb. GVW, but extension of that category to 8500 lb. GVW is under consideration. The vehicle categories are chosen on the basis of present and probable future emission regulation.

TABLE 2

PROJECTED PERCENT EMISSIONS CONTRIBUTIONS FOR $NO_X$

**(For Assumptions and Calculation Methods, see Appendicies 1-5)**

| City | Year | LDV | LDT | HDG | HDD | Other | SS |
|---|---|---|---|---|---|---|---|
| Phoenix | 72 | 36 | 6 | 2 | 19 | 8 | 30 |
| | 75 | 35 | 6 | 2 | 17 | 9 | 32 |
| | 80 | 29 | 5 | 1 | 15 | 11 | 39 |
| | 85 | 25 | 5 | 1 | 10 | 14 | 46 |
| | 90 | 24 | 5 | 1 | 8 | 14 | 48 |
| Los Angeles | 72 | 36 | 5 | 4 | 11 | 6 | 38 |
| | 75 | 35 | 5 | 4 | 10 | 6 | 40 |
| | 80 | 28 | 4 | 3 | 9 | 8 | 49 |
| | 85 | 24 | 4 | 3 | 55 | 9 | 56 |
| | 90 | 23 | 4 | 2 | 4 | 10 | 58 |
| San Francisco | 72 | 31 | 6 | 4 | 11 | 10 | 38 |
| | 75 | 30 | 6 | 4 | 10 | 11 | 40 |
| | 80 | 24 | 5 | 3 | 8 | 14 | 48 |
| | 85 | 20 | 4 | 2 | 5 | 16 | 54 |
| | 90 | 19 | 4 | 2 | 4 | 16 | 55 |
| Denver | 72 | 31 | 5 | 7 | 11 | 6 | 40 |
| | 75 | 30 | 5 | 7 | 10 | 6 | 42 |
| | 80 | 24 | 4 | 5 | 8 | 8 | 51 |
| | 85 | 20 | 3 | 4 | 5 | 9 | 58 |
| | 90 | 19 | 3 | 3 | 4 | 10 | 60 |
| New York City | 72 | 37 | 7 | 2 | 8 | 3 | 43 |
| | 75 | 36 | 7 | 2 | 7 | 3 | 45 |
| | 80 | 28 | 5 | 2 | 6 | 4 | 54 |
| | 85 | 24 | 5 | 1 | 4 | 5 | 61 |
| | 90 | 23 | 5 | 1 | 3 | 5 | 63 |
| Philadelphia | 72 | 28 | 5 | 2 | 12 | 4 | 50 |
| | 75 | 26 | 4 | 2 | 11 | 4 | 52 |
| | 80 | 20 | 3 | 2 | 9 | 6 | 60 |
| | 85 | 17 | 3 | 1 | 5 | 6 | 67 |
| | 90 | 16 | 3 | 1 | 4 | 7 | 69 |
| Washington, D.C. | 72 | 29 | 5 | 3 | 9 | 5 | 50 |
| | 75 | 27 | 4 | 3 | 8 | 6 | 52 |
| | 80 | 21 | 4 | 2 | 7 | 7 | 60 |
| | 85 | 17 | 3 | 2 | 4 | 8 | 66 |
| | 90 | 17 | 3 | 1 | 3 | 8 | 68 |
| Chicago | 72 | 28 | 4 | 2 | 12 | 4 | 50 |
| | 75 | 27 | 4 | 2 | 11 | 4 | 52 |
| | 80 | 21 | 3 | 1 | 9 | 5 | 61 |
| | 85 | 17 | 3 | 1 | 6 | 5 | 68 |
| | 90 | 17 | 3 | 1 | 4 | 6 | 70 |
| Baltimore | 72 | 22 | 4 | 1 | 3 | 8 | 61 |
| | 75 | 21 | 4 | 1 | 3 | 9 | 62 |
| | 80 | 15 | 3 | 1 | 2 | 10 | 69 |
| | 85 | 12 | 2 | 1 | 1 | 11 | 73 |
| | 90 | 11 | 2 | 1 | 1 | 11 | 74 |
| Salt Lake City | 72 | 24 | 2 | 5 | 14 | 5 | 50 |
| | 75 | 23 | 2 | 5 | 13 | 5 | 52 |
| | 80 | 17 | 2 | 4 | 10 | 6 | 61 |
| | 85 | 15 | 2 | 3 | 6 | 7 | 68 |
| | 90 | 14 | 2 | 2 | 5 | 8 | 70 |
| Composite City | 72 | 32 | 5 | 3 | 10 | 5 | 45 |
| | 75 | 31 | 5 | 3 | 9 | 5 | 47 |
| | 80 | 24 | 4 | 2 | 7 | 7 | 55 |
| | 85 | 20 | 4 | 2 | 5 | 8 | 62 |
| | 90 | 20 | 4 | 1 | 4 | 8 | 64 |

this report. The reasons that a .4 gpm $NO_x$ limit for LDV in 1978 is not used are:

1. $NO_2$ concentration is greater than the air quality standard in only two locations (Los Angeles and Chicago).
2. LDV contribute less than one third of the $NO_x$ emitted at present except for the Los Angeles area.
3. $NO_x$ emission control technology for achieving .4 gpm is developmental, expensive, and of questionable reliability at present.
4. EPA has recommended that the date of .4 gpm implementation be delayed.

Carbon monoxide, unlike NMHC and $NO_x$ is a very local problem, not a regional or citywide problem. High CO concentrations are associated with high traffic densities, particularly along constricted corridors with poor ventilation. The percent contribution of the several mobile source categories to CO emissions is presented as three cases related to local traffic conditions (Table 7) rather than for specific regions.

Since it is not known which of the parameters affecting emissions and air quality will be changed due to fuel economy considerations, nor how much change is likely, this report has been developed as a handbook which permits persons relatively unfamiliar with air quality modeling to calculate the effects on air quality of changes in emission rate, vehicle mix etc.

## 2.2 CONCLUSIONS

The impact of fuel economy improvements on air quality are uncertain, but the following conclusions can be drawn:

- Fuel economy improvements are not likely to have much impact on emissions or air quality provided that mobile source emission standards are not altered for fuel economy purposes.
- Emissions would be increased if the emission standards

applicable to one or more categories of emissions were relaxed or delayed.

- A change to alternative power systems may lead to an increase in the emissions of currently uncontrolled pollutants from motor vehicles. Particulate emissions and odor from light duty diesels, for example, might adversely impact air quality if large quantities of autos and pick-up and delivery trucks are converted to state-of-the-art diesel engines.
- A relaxation or delay in the application of the .4 gpm $NO_x$ standard for LDV would have little impact on air quality but would allow better fuel economy or lower emission control cost or a superior compromise between first cost and fuel economy.

# 3. AIR QUALITY MODELS

The concentration of $O_x$ and $NO_2$ in future urban atmospheres is estimated from a linear, proportional model where concentration varies in proportion to total urban emissions of NMHC and $NO_x$. The model may be written:

$$\frac{x - b}{x_o - b} = \frac{\sum^{J} P_j \; ef_j \; gf_j}{100\%} \qquad (1)$$

where $x$ = future concentration

$x_o$ = base (1972) concentration

$b$ = background concentration

$P_j$ = percent contribution of the jth source category to total urban emission

$ef_j$ = the emission factor ratio. This is the ratio of the expected emission factor for the jth source category in the projected year to the emission factor for that category in the base year (1970)

$gf_j$ = the growth factor. This is the growth of the emissions of a source category due to increased activity (e.g., vehicle miles) over the projection period. $gf_j = (1+r_j)^n$ where $r$ = the annual growth rate.

The concentration of CO is most heavily influenced by local traffic density. A very simple model is used which attributes all change in CO to changes in local traffic emission and assumes no growth in traffic density in those areas where CO is a serious problem.

$$\frac{x - b}{x_o - b} = \frac{\sum^{J} P_j \; ef_j}{100\%} \qquad (2)$$

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# 4. EXPECTED CONDITIONS

The impact of a fuel economy measure on air quality depends on the change in emissions caused by the measure and on the percentage of total relevant emissions produced by the affected source category. For example, if LDV are expected to contribute 50 percent of NMHC emissions in a given city in 1980, and a fuel economy measure would cause a 10 percent increase in emission per LDV, then the impact of that measure on the cities' oxidant concentration would be estimated as 10% x 50% = 5% increase.

In order to estimate the percent contribution of the several source categories to total emissions at future dates, the following information is needed:

For NMHC and $NO_x$

1. Initial (1972) emissions for each source category. This is presented for 10 cities and an "average" city in Tables 1 and 2.
2. Expected growth rates for each source category. These are taken as 3%/year for LDV and 4%/year for all other source categories. Growth factors based on these growth rates are presented in Table 3.
3. Expected emission factor changes for each source category. These are presented in the form of emission factor ratios in Tables 4 and 5. The method of calculating these emission factor ratios and the assumptions involved are presented in Appendix 4.

These base emission contributions, growth factors, and emission factor ratios are used as input to equation (1) to produce the expected emission contributions of NMHC and $NO_x$ for 10 cities and the "average" city in Tables 1 and 2.

For CO, the key factors for estimating the expected change in future air quality are the category emission factor ratios (Table 6) and the vehicle category mixes. The vehicle mix will vary

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TABLE 3. GROWTH FACTORS*

| n (Years) | Growth Rate (%/year) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2% | 2.5% | 3% | 3.5% | 4% | 4.5% | 5% |
| 0 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2 | 1.04 | 1.05 | 1.06 | 1.07 | 1.08 | 1.09 | 1.10 |
| 4 | 1.08 | 1.10 | 1.13 | 1.15 | 1.17 | 1.19 | 1.22 |
| 6 | 1.13 | 1.16 | 1.19 | 1.23 | 1.27 | 1.30 | 1.34 |
| 8 | 1.17 | 1.22 | 1.27 | 1.32 | 1.37 | 1.42 | 1.48 |
| 10 | 1.22 | 1.28 | 1.34 | 1.41 | 1.48 | 1.55 | 1.63 |
| 12 | 1.27 | 1.34 | 1.43 | 1.51 | 1.60 | 1.70 | 1.80 |
| 14 | 1.32 | 1.41 | 1.51 | 1.62 | 1.73 | 1.85 | 1.98 |
| 16 | 1.37 | 1.48 | 1.60 | 1.73 | 1.87 | 2.02 | 2.18 |
| 18 | 1.43 | 1.56 | 1.70 | 1.86 | 2.03 | 2.21 | 2.41 |
| 20 | 1.49 | 1.64 | 1.81 | 1.99 | 2.19 | 2.41 | 2.65 |

*$gf = (1 + r)^n$

TABLE 4. HC EMISSION FACTOR RATIOS

| Year | LDV | LDT | HDG | HDD | Other | GE | New/Old SS |
|---|---|---|---|---|---|---|---|
| 75 | .51 | .51 | .55 | .74 | 1.0 | 1.0 | .60/.97 |
| 80 | .18 | .18 | .22 | .43 | 1.0 | .2 | .58/.87 |
| 85 | .07 | .07 | .07 | .26 | 1.0 | .2 | .56/.65 |
| 90 | .05 | .05 | .04 | .22 | 1.0 | .2 | .56/.65 |

See Appendices 1-5 For Assumptions and Methods.

TABLE 5. $NO_x$ EMISSION FACTOR RATIOS

| Year | LDV | LDT | HDG | HDD | Other | New/Old SS |
|---|---|---|---|---|---|---|
| 75 | .92 | .92 | .93 | .85 | 1.0 | .81/1.0 |
| 80 | .60 | .60 | .55 | .55 | 1.0 | .81/.96 |
| 85 | .46 | .46 | .39 | .30 | 1.0 | .81/.96 |
| 90 | .44 | .44 | .28 | .23 | 1.0 | .81/.96 |

See Appendicies 1-5 for Assumptions and Methods.

TABLE 6. CO EMISSION FACTOR RATIOS

| Year | LDV | LDT | HDG | HDD |
|---|---|---|---|---|
| 75 | .60 | .60 | .73 | .77 |
| 80 | .22 | .22 | .50 | .54 |
| 85 | .07 | .07 | .36 | .39 |
| 90 | .09 | .09 | .32 | .36 |

See Appendicies 1-5 for Assumptions and Methods.

within the city at least as much as between cities so no city specific data is presented. The base (1972) vehicle category contribution to CO emissions is presented as a set of three alternatives:

| CASE | LDV | LDT | HDG | HDD |
|---|---|---|---|---|
| A | 80% | 10% | 9% | 1% |
| B | 70% | 15% | 13% | 2% |
| C | 60% | 20% | 17% | 3% |

These alternatives represent (a) the average national vehicle mix; (b) a somewhat greater proportion of trucks as found in portions of cities and (c) a high proportion of trucks as found in certain central cities (e.g., New York City).

Table 7 contains the expected contributions of emissions to high urban CO concentrations for the three alternative distributions.

TABLE 7. PROJECTED PERCENTAGE EMISSIONS CONTRIBUTIONS FOR CO

| Year | Case | LDV | LDT | HDG | HDD |
|---|---|---|---|---|---|
| 1970 | A | 80 | 10 | 9 | 1 |
| | B | 70 | 15 | 13 | 2 |
| | C | 60 | 20 | 17 | 3 |
| 1975 | A | 78 | 10 | 11 | 1 |
| | B | 68 | 15 | 15 | 2 |
| | C | 57 | 19 | 20 | 4 |
| 1980 | A | 71 | 9 | 18 | 2 |
| | B | 59 | 13 | 25 | 4 |
| | C | 46 | 16 | 31 | 6 |
| 1985 | A | 57 | 7 | 32 | 4 |
| | B | 43 | 9 | 41 | 7 |
| | C | 33 | 11 | 47 | 9 |
| 1990 | A | 47 | 6 | 41 | 6 |
| | B | 33 | 9 | 49 | 8 |
| | C | 25 | 8 | 56 | 11 |

See Appendicies 1-5 for Assumptions and Methods.

## 5. CHANGES DUE TO FUEL ECONOMY MEASURES

There are three ways in which a fuel economy measure could alter the emissions from mobile sources:

1. The emission-per-vehicle mile (emission factor) could be altered. This would occur if;
   a. The emission standard for a category of vehicles was altered, or
   b. If the date of application of an emission standard was altered.
2. The mix of vehicle categories could be altered. Since vehicle categories have different emission factors, a change in the mix would cause a change in the composite emissions.
3. The growth rate of a vehicle category could be altered. The results of changes in the timing of emission standards are shown in Tables 8 through 10. The use of these tables is illustrated in the following example.

Suppose a fuel economy measure would delay application of the statutory HC emission limit on LDV from 1977 to 1980. And the projected year of interest is 1985. Table 8 indicates the percent change in the emission factor ratio due to a 3 year delay in the application of the statutory standard is 60% in 1980. If the impact of this change on the "average city" was desired, Table 1 would be consulted. That table shows that LDV are expected to contribute 14% of the HC emissions in "average city" 1985. The impact of the measure on photochemical oxidants in "average city" in 1985 would be estimated as 60% x 14% = 8.4% increase.

The results of vehicle mix changes apart from growth rate changes (which would affect vehicle mix) are considered only for the case of heavy trucks. The use of more diesel engines and less gasoline engines would decrease both CO and HC emissions. The expected mix of miles traveled by heavy-duty gasoline and diesel

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TABLE 8. PERCENT CHANGE OF EMISSION FACTOR RATIO FOR LIGHT-DUTY VEHICLES

| Pollutant | Year Under Consideration | Year Standards Take Effect | | | |
|---|---|---|---|---|---|
| | | 77 | 78 | 80 | Never* |
| HC | 1980 | 0[1] | +7 | +26 | 31 |
| | 1985 | 0 | 14 | 45 | 174 |
| | 1990 | 0 | 0 | 13 | 268 |
| $NO_x$ | 1980 | ** | -21 | -5 | 0[2] |
| | 1985 | ** | -59 | -49 | 0 |
| | 1990 | ** | -71 | -68 | 0 |
| CO | 1980 | 0[3] | +9 | +35 | +41 |
| | 1985 | 0 | 20 | 68 | 272 |
| | 1990 | 0 | 0 | 22 | 480 |

*interim standards remain indefinitely

**Not calculated; the earliest a 0.40 gpm emission standard might be applied is 1978.

---

1 The emission factor ratios for HC presented in Table 4 are based on the assumption that the HC emission standard is changed from 1.5 to .41 gpm in 1977.

2 The emission factor ratio for $NO_x$ presented in Table 5 are based on the assumption that the $NO_x$ emission standard remains at 2.0 gpm after 1976.

3 The emission factor ratios for CO presented in Table 6 are based on the assumption that the CO emission standard is changed from 15 to 3.4 gpm in 1977.

TABLE 9. PERCENT CHANGE OF EMISSION FACTOR RATIO FOR HEAVY-DUTY GASOLINE VEHICLES

| Pollutant | Year Under Consideration | Year Standards Take Effect | | | |
|---|---|---|---|---|---|
| | | 75 | 78[a] | 80[b] | Never[c] |
| HC | 1980 | 0 | +30 | 58 | 67 |
| | 1985 | 0 | 26 | 86 | 289 |
| | 1990 | 0 | 0 | 122 | 605 |
| $NO_x$ | 1980 | 0 | 37 | 72 | 83 |
| | 1985 | 0 | 16 | 51 | 168 |
| | 1990 | 0 | 0 | 56 | 269 |
| CO | 1980 | 0 | 14 | 27 | 31 |
| | 1985 | 0 | 6 | 26 | 67 |
| | 1990 | 0 | 0 | 28 | 90 |

[a] 75 standards delayed until 1978

[b] 73/74 standards apply until 1980, and 1980 standards apply thereafter

[c] 73/74 standards apply indefinitely

See Appendix I for assumed HDG emission standards.

TABLE 10. PERCENT CHANGE OF EMISSION FACTOR RATIO FOR HEAVY-DUTY DEISEL VEHICLES

| Pollutant | Year Under Consideration | Year Standards Take Effect | | | |
|---|---|---|---|---|---|
| | | 75 | 78[a] | 80[b] | Never[c] |
| HC | 1980 | 0 | 20 | 39 | 46 |
| | 1985 | 0 | 8 | 33 | 104 |
| | 1990 | 0 | 0 | 33 | 144 |
| $NO_x$ | 1980 | 0 | 13 | 29 | 33 |
| | 1985 | 0 | 6 | 68 | 120 |
| | 1990 | 0 | 0 | 102 | 193 |
| CO | 1980 | 0 | 5 | 11 | 12 |
| | 1985 | 0 | 2 | 20 | 35 |
| | 1990 | 0 | 0 | 25 | 46 |

[a]75 standards delayed until 1978

[b]73/74 standards apply until 1980, and 1980 standards apply thereafter

[c]73/74 standards apply indefinitely

See Appendix I for assumed HDD emission standards.

vehicles is shown in Table 11. The change in emissions due to a deviation from these mixes is estimated as in the following example.

Suppose the mix of heavy vehicles (HDG/HDD) is changed from 60:40 to 50:50 in 1985. The percent change in HDG is:

$$\frac{50 - 60}{40} \times 100 = -16.7\%$$

The percent change in HDD is:

$$\frac{50 - 40}{40} \times 100 = +25\%$$

If the impact on Los Angeles' air quality is desired, then, from Tables 1 and 2 the 1985 percent contribution of HC and $NO_x$ from HDG and HDD are:

| | HDG | HDD |
|---|---|---|
| HC | 1% | 1% |
| $NO_x$ | 3% | 5% |

These contributions are multiplied by the percent change found above as follows:

| | HDG | HDD | NET CHANGE |
|---|---|---|---|
| HC -17% x 1% = | -.17% | + 25% x 1% = + .25% | +.08% |
| $NO_x$ -17% x 3% = | -.5% | + 25% x 5% = + 1.25% | +.75% |

The change in CO may be estimated in a similar manner from any (or all) of the three cases given in Table 9. For 1985 these are:

| | CHANGE IN HDG | CHANGE IN HDD | NET CHANGE |
|---|---|---|---|
| Case A | -17 x 32 = -5.4% | +25 x 4 = +1 % | -3.4% |
| Case B | -17 x 41 = -7.0% | +25 x 7 = +1.8% | -5.2% |
| Case C | -17 x 47 = -8.0% | +25 x 9 = +2.3% | -5.7% |

The estimated net result of a change in HDG/HDD mix from 60:40 to 50:50 in 1985 in Los Angeles is:

| | | | |
|---|---|---|---|
| CO | -3 % to -6 % | $NO_2$ | 1% |
| Oxidants | Negligable change | | |

TABLE 11.

HEAVY DUTY VEHICLE MILEAGE RATIOS

(Gasoline-powered:Diesel-powered)

| City | Ratio |
|---|---|
| Phoenix | 20:80 |
| Southeast Desert | 65:35 |
| Los Angeles | 55:45 |
| Sacramento | 60:40 |
| San Diego | 60:40 |
| San Francisco | 55:45 |
| Denver | 70:30 |
| New York City | 50:50 |
| Philadelphia | 45:55 |
| Boston | 60:40 |
| Baltimore | 60:40 |
| Chicago | 35:65 |
| Las Vegas | 50:50 |
| Dayton | 40:60 |
| Washington, D. C. | 50:50 |
| Salt Lake City | 50:50 |

| Composite City | |
|---|---|
| HC | 55:45 |
| $NO_x$ | 50:50 |

If a fuel economy measure is expected to change the growth rate of a source category, the percent change in growth factor may be found in Table 12. The table is used as follows:

TABLE 12. PERCENT CHANGE IN GROWTH FACTORS* DUE TO A CHANGE IN GROWTH RATE

| Years | +1% | +.5% | -.5% | -1% |
|---|---|---|---|---|
| 2 | 1.9 | 1.0 | -1.0 | -1.9 |
| 4 | 3.9 | 1.9 | -1.9 | -3.8 |
| 6 | 5.9 | 2.9 | -2.9 | -5.7 |
| 8 | 8.0 | 3.9 | -3.8 | -7.5 |
| 10 | 10.1 | 4.9 | -4.7 | -9.3 |
| 12 | 12.2 | 6.0 | -5.6 | -11.0 |
| 14 | 14.4 | 7.0 | -6.6 | -12.7 |
| 16 | 16.6 | 8.0 | -7.5 | -14.4 |
| 18 | 18.9 | 9.1 | -8.3 | -16.0 |
| 20 | 21.2 | 10.1 | -9.2 | -17.6 |

* $$P_{\Delta gf} = \frac{(1+r)^n - (1+r_o)^n}{(1+r_o)^n}$$

Suppose a fuel economy measure would reduce the growth rate of LDV by 1%/year beginning in 1980 (e.g., from 3%/year to 2%/year). The effects of this measure on growth factors in 1985 and 1990 are found from Table 12 as approximately -4.7% and -9.3% respectively. For example if the effects of these changes on $NO_2$ concentration in Chicago are desired, then the contributions of $NO_x$ by LDV in Chicago in 1985 and 1990 are found from Table 2, and multiplied by the percent changes in growth factors, thus:

| Year | Base Contribution | Growth Factor Chenge | Estimated $NO_2$ Change |
|---|---|---|---|
| 1985 | 17% | -4.7% | -.8% |
| 1990 | 17% | -9.3% | -1.6% |

Fuel economy measures could also reduce the amount of gasoline transferred and thus reduce the evaporative loss of NMHC from those transfers. Table 1 includes the expected contribution of gasoline transfer to NMHC emissions. This contribution would be reduced to the extent that gasoline transfer was reduced.

For example, suppose that gasoline demand in New York City were reduced 10 percent by fuel economy measures. The percent contributions of fuel evaporation in New York in 1985 and 1990 are (from Table 6) 2% and 2% respectively. The estimated impact on oxidant formation over New York City would be 10 percent of these figures or -.2% in 1985 and -.2% in 1990.

# APPENDIX 1

## MOBILE SOURCE EMISSION LIMIT ASSUMPTIONS

## APPENDIX 1
## MOBILE SOURCE EMISSION LIMIT ASSUMPTIONS

LDV Emission Limits (gpm)

| | HC | $NO_x$ | CO |
|---|---|---|---|
| 1975 | 1.5 | 3.1 | 15.0 |
| 1976 | 1.5 | 2.0 | 15.0 |
| 1977 onward | 0.41 | 2.0 | 3.4 |

Society of Automotive Engineers' Heavy Duty Vehicle Emission Projections (gpm)

| | Gas | | | Diesel | | |
|---|---|---|---|---|---|---|
| | HC | $NO_x$ (as $NO_2$) | CO | HC | $NO_x$ (as $NO_x$) | CO |
| 1973/1974 | 6.12 | 18.36 | 61.2 | 3.45 | 34.5 | 20.7 |
| 1975-1979 | 1.53 | 6.12 | 38.3 | 1.73 | 22.4 | 17.3 |
| 1980 onward | 76 | 4.59 | 30.6 | 1.39 | 10.4 | 13.8 |

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# APPENDIX 2
# DETERIORATION FACTORS

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# APPENDIX 2
## DETERIORATION FACTORS

TABLE 2-1. LIGHT DUTY GASOLINE POWERED VEHICLES DETERIORATION FACTORS

| Pollutant and Model Year | Vehicle age (years) 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | ≥9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Exhaust HC | | | | | | | | | | |
| Pre-1968[a] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1968 | 1.00 | 1.12 | 1.18 | 1.21 | 1.23 | 1.26 | 1.28 | 1.30 | 1.32 | 1.35 |
| 1969 | 1.00 | 1.10 | 1.16 | 1.18 | 1.21 | 1.23 | 1.25 | 1.28 | 1.29 | 1.31 |
| 1970 through 1974[b] | 1.00 | 1.05 | 1.10 | 1.13 | 1.15 | 1.17 | 1.20 | 1.22 | 1.24 | 1.26 |
| 1975[c] | 1.00 | 1.00 | 1.13 | 1.22 | 1.29 | 1.37 | 1.43 | 1.50 | 1.56 | 1.63 |
| Post 1975[c] | 1.00 | 1.14 | 1.30 | 1.44 | 1.55 | 1.67 | 1.77 | 1.88 | 1.96 | 2.07 |
| $NO_x$ | | | | | | | | | | |
| Pre-1973[a] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1973 through 1974[d] | 1.00 | 1.11 | 1.18 | 1.20 | 1.21 | 1.22 | 1.23 | 1.24 | 1.25 | 1.26 |
| 1975[c] | 1.00 | 1.00 | 1.18 | 1.23 | 1.23 | 1.41 | 1.45 | 1.45 | 1.45 | 1.45 |
| 1976[c] | 1.00 | 1.03 | 1.07 | 1.10 | 1.13 | 1.17 | 1.19 | 1.21 | 1.24 | 1.26 |
| Post 1976[c] | 1.00 | 1.17 | 1.37 | 1.53 | 1.67 | 1.82 | 1.94 | 2.06 | 2.17 | 2.32 |
| CO | | | | | | | | | | |
| Pre-1968[a] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1968 | 1.00 | 1.24 | 1.35 | 1.41 | 1.47 | 1.53 | 1.58 | 1.63 | 1.67 | 1.72 |
| 1969 | 1.00 | 1.42 | 1.53 | 1.59 | 1.63 | 1.68 | 1.71 | 1.75 | 1.79 | 1.82 |
| 1970 through 1974[b] | 1.00 | 1.18 | 1.32 | 1.38 | 1.40 | 1.44 | 1.47 | 1.50 | 1.51 | 1.56 |
| 1975[c] | 1.00 | 1.04 | 1.30 | 1.36 | 1.43 | 1.44 | 1.49 | 1.56 | 1.63 | 1.69 |
| Post 1975[c] | 1.00 | 1.16 | 1.34 | 1.50 | 1.62 | 1.75 | 1.88 | 2.00 | 2.10 | 2.22 |

[a]Values of unity are given for Pre-1968 vehicles because they were not equipped with exhaust control devices and, therefore are not subject to exhaust control device deterioration. Deterioration in the emission performance of pre-1968 vehicles because of poor maintenance, age, etc., is taken into account by their emission factors, which are based on a random sample of vehicles.

[b]Based on test results for 1970 model year vehicles.

[c]Based on Reference 5 and on unpublished EPA test data. Deterioration factors based on tests of prototype 1976-1977 model year vehicles.

[d]Based on test results for 1971 (California) model year vehicles.

TABLE 2-2. HEAVY DUTY GASOLINE POWERED VEHICLE DETERIORATION FACTORS

| Pollutant and Model Year | Vehicle age (years) 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ≥11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Exhaust HC | | | | | | | | | | | |
| Pre-1969 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 1969 through 1974 | 1.0 | 1.14 | 1.19 | 1.23 | 1.26 | 1.28 | 1.30 | 1.31 | 1.32 | 1.33 | 1.36 |
| 1975 through 1979 | 1.0 | 1.16 | 1.21 | 1.25 | 1.28 | 1.31 | 1.33 | 1.35 | 1.36 | 1.38 | 1.42 |
| Post 1979 | 1.0 | 1.18 | 1.22 | 1.28 | 1.31 | 1.34 | 1.36 | 1.38 | 1.40 | 1.31 | 1.45 |
| $NO_x$ (as $NO_2$) | | | | | | | | | | | |
| Pre-1972 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 1973 through 1974 | 1.0 | 1.16 | 1.21 | 1.25 | 1.28 | 1.31 | 1.33 | 1.35 | 1.36 | 1.38 | 1.42 |
| 1975 through 1979 | 1.0 | 1.18 | 1.22 | 1.28 | 1.31 | 1.34 | 1.36 | 1.38 | 1.40 | 1.41 | 1.45 |
| Post-1979 | 1.0 | 1.20 | 1.26 | 1.30 | 1.34 | 1.38 | 1.40 | 1.42 | 1.44 | 1.45 | 1.50 |
| CO | | | | | | | | | | | |
| Pre-1969 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 1969 through 1972 | 1.0 | 1.16 | 1.21 | 1.25 | 1.28 | 1.31 | 1.33 | 1.35 | 1.36 | 1.38 | 1.42 |
| 1973 through 1979 | 1.0 | 1.18 | 1.22 | 1.28 | 1.31 | 1.34 | 1.36 | 1.38 | 1.40 | 1.41 | 1.45 |
| Post 1979 | 1.0 | 1.20 | 1.26 | 1.30 | 1.34 | 1.38 | 1.40 | 1.42 | 1.44 | 1.45 | 1.50 |

NOTE: For heavy duty diesel vehicles, no deterioration was assumed — i.e., all deterioration factors = 1. Heavy duty gas vehicle deterioration factors were obtained from "Emissions and Fuel Usage by the U.S. Truck and Bus Population and Strategies for Achieving Reductions" by Tingley and Johnson for the Society of Automotive Engineers.

# APPENDIX 3

## FRACTIONAL MILEAGE BY VEHICLE AGE

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## APPENDIX 3
## FRACTIONAL MILEAGE BY VEHICLE AGE

| | Vehicle Age (years) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| LDV's<br>LDT's | .013 | .075 | .174 | .135 | .123 | .115 | .097 | .083 | .060 | .059 | .027 | .017 | .010 | .032 |
| HDV's | .003 | .095 | .164 | .121 | .114 | .097 | .088 | .064 | .054 | .036 | .028 | .018 | .015 | .103 |

*refers to the mileage of model year (X+1) cars introduced in fall of year (X).

# APPENDIX 4

# THE CALCULATION OF EMISSION FACTOR RATIOS

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## APPENDIX 4
## THE CALCULATION OF EMISSION FACTOR RATIOS

An emission factor ratio is, as the words imply, a ratio of two emission factors, typically the ratio of the emission factor in some projection year to the emission factor in the base year.

To calculate emission factors for any mobile source category, it is necessary to calculate an average of the emissions per mile for all vehicles within that vehicle category. To calculate these averaged emission factors, one takes a weighted average of the low mileage emissions per mile times the deterioration factor, using mileage as the weighting factor. Also, if the pollutant is hydrocarbon, emissions from evaporation and perhaps crankcase blowby must be added. In mathematical terms:

$$e.f._n = \sum_i \left(c_i d_{in} + h_i\right) m_{in}$$

where:

$e.f._n$ = emission factor for calendar year n

$c_i$ = low mileage emission rate for $i^{th}$ model year

$d_{in}$ = deterioration factor for $i^{th}$ model year in calendar year n

$h_i$ = evaporation and crankcase blowby for $i^{th}$ model year (HC only)

$m_{in}$ = mileage of $i^{th}$ model year in calendar year n.

A simplified example will demonstrate the utilization of this formulation. Let us suppose for this example that cars are used only three years, that on the average they travel 30% of their ultimate mileage the first calendar year, 40% the second calendar year, and 30% the third calendar year. Now suppose we want to calculate an emission factor for 1978 automobiles for hydrocarbons. Let us suppose for the sake of this example that cars coming into



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operation in 1976 emit 1.3 gpm and in their third year have a deterioration factor of 1.2, cars coming in 1977 emit 1.3 gpm and in 1978 have a deterioration factor of 1.1, and cars coming in 1978 emit 0.2 gpm and in 1978 have a deterioration factor of 1.1. Let us suppose that miscellaneous hydrocarbon emissions for all three years is 0.2 gpm. Then we have:

$$
\begin{aligned}
&(1.3 \times 1.2 + 0.2) \times 30\% \\
&+(1.3 \times 1.1 + 0.2) \times 40\% \\
&\underline{+( .2 \times 1.1 + 0.2) \times 30\%} \\
&=1.76 \times 30\% + 1.63 \times 40\% + .42 \times 30\% \\
&=1.31 \text{ gpm}
\end{aligned}
$$

Calculation of a mobile source emission factor ratio requires the calculation of two emission factors, one for the projection year and one for the base year. The emission factor ratio is simply a ratio of the former to the latter. Thus, to continue the above example, if we found that cars in the base year of 1970 had an average emission factor of 10.0 gpm, then the emission factor ratio for 1978 would be 1.31/10.0 = .131.

Calculating the emission factor ratio for stationary sources requires an estimate of the degree to which base year emissions of each source category are expected to be controlled during the projection year. It may be represented by:

$$e.f. = \sum_j P_j \left(\frac{E'}{E}\right) \Big/ \sum_j P_j$$

where:

$j$ = subcategory

$P_j$ = percentage of total source category emissions from subcategory $j$ during base year

$E'$ = emissions during projection year

$E$ = emissions during base year.

To show a hypothetical example, imagine a place where power plants emit 30% of the pollutant under consideration and industrial sources emit the other 70%. Then suppose we look at the emissions regulations and estimate that power plants will be controlled by 20%, i.e., they will emit 80% as much in the projection year as in the base year. Suppose we also estimate that industrial sources will be controlled by 60%, i.e., they will emit 40% as much in the projection year as in the base year. Then e.f. = (.30 x .80 x .70 x .40)/1.00 = .52.

# APPENDIX 5

## SOURCES OF DATA



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# APPENDIX 5
## SOURCES OF DATA

I. Primary Sources of Data

Compilation of Air Pollutant Emission Factors, with Supplement 2, AP-42, main report published April 1973, Supplement published Sept. 1973 (hereafter referred to as "AP-42").

Kircher, D.S. and D.P. Armstrong, An Interim Report on Motor Vehicle Emission Estimation, EPA-450/2-73-003, Oct. 1973 (hereafter referred to as "Kircher and Armstrong").

National Emissions Data System, NADB, OAQPS, EPA, Research Triangle Park, N.C. 27711 (hereafter referred to as "NEDS").

Tingley, D.S. and J.H. Johnson, "Emissions and Fuel Usage by the U.S. Truck and Bus Population and Strategies for Achieving Reductions," prepared for the Society of Automotive Engineers, June 1974 (hereafter referred to as "SAE Report").

II. Specific Data Sources, by Source Category

a. Light-Duty Vehicles (LDV).

1. Emissions

HC: Q (emissions) = 88.9% x [Gasoline - Vehicles Emissions (from NEDS)].

$NO_x$ = Q (emissions = 89.6% x [Gasoline - Light Vehicles Emissions (from NEDS)].

Note: The rest of gasoline-powered light vehicle emissions are considered to be from light duty trucks.

2. Emission Factor Ratios

Low mileage emissions: AP-42, except the emissions for 1975 cars were used for 1976 cars to reflect the statutory extension of the interim standards.

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Deterioration factors: AP-42

Non-exhaust emissions (HC only): AP-42

Relative mileage: Kircher and Armstrong

b. Light Duty Trucks (LDT)

1. Emissions

For HC: Q = 11.1% x [Gasoline - Light Vehicles Emissions (from NEDS)] + 28.5% x [Gasoline - Heavy Vehicles Emissions (from NEDS)].

For $NO_x$: Q = 10.4% x [Gasoline - Light Vehicles Emissions (from NEDS)] + 28.5% x [Gasoline - Heavy Vehicles Emissions (from NEDS)].

Note: These percentages are obtained from estimates of relative national mileage and emission factors in 1970. It was assumed consumption was emitted by heavy duty diesel-vehicles.

2. Emission Factor Ratios

For lack of better information, LDT's were assumed to have same emission factor ratios as LDV's.

c. Heavy Duty Vehicles, Gasoline Powered.

1. Emissions

Q = 71.5% x [Gasoline - Heavy Vehicles (from NEDS).

2. Emission Factor Ratios

Low mileage emissions: SAE Report

Deterioration Factors: SAE Report

Non-exhaust emissions (HC only): SAE Report

Relative mileage: Kircher and Armstrong

d. Heavy Duty Vehicles, Diesel Powered.

1. Emissions

Q = [Diesel - Heavy Vehicles (from NEDS)].

2. Emission Factor Ratios

Low mileage emissions: SAE Report

Deterioration factors: SAE Report

Non-exhaust emissions (HC only): SAE Report

Relative mileage: Kircher and Armstrong

e. Other.

1. Emissions

All off-highway transportation emissions from NEDS except gas handling.

2. Emission Factor Ratios

It was assumed for the purpose of this study that there would be no control of off-highway sources.

f. Gas Handling

1. Emissions

Gas handling from NEDS

2. Emission Factor Ratios

Although gas handling emissions regulations are mandated only for cities with the more critical oxidant problems, 80% control was assumed to be a reasonable average degree of control.

g. Stationary Sources

1. Emissions

All emissions from NEDS except transportation emissions.

2. Emission Factor Ratios

Two emission factor ratios were determined -- one for new sources and one for existing sources. Stationary source emissions were divided into three categories: power plants, industrial sources, and other stationary sources. For HC, each of these categories was subdivided, and the two emission factor ratios for the respective category were determined by first making a

subjective estimate of the expected degree of control for each subcategory based on regulations coming into effect, then finding a weighted average, weighted by city-specific emissions totals. (This procedure is explained in more detail in Appendix 4). The 10 city-specific emission factor ratios for each of the three categories for both new and existing sources were then averaged into six city-specific emission factor ratios. A composite emission factor ratio for new sources was then determined as the weighted average of the averaged emission factor ratios for each category, weighted by the total of the 10 cities' emissions for the respective category. An emission factor ratio for old sources was similarly determined. For $NO_x$, emission factor ratios were used from a rough draft of "$NO_x$ Analysis Report" by the EPA. Again the composite stationary source emission factor ratios, one each for new sources and old sources, were calculated as a weighted average of the emission factor ratios for each category, weighted by the total emissions for each categories of NEDS were apportioned among the three stationary source categories that were used in determining emission factor ratios (power plants, industrial sources, and other stationary sources).

TABLE 5-1. APPORTIONMENT OF EMISSIONS AMONG STATIONARY SOURCE CATEGORIES

| NEDS Listing | Source Category* |
|---|---|
| Fuel Combustion (external and internal) | |
| Residential | O |
| Electric Generation | PP |
| Industrial | I |
| Comm-institutional | O |
| Industrial Process | I |
| Solid Waste Disposal | |
| Residential | O |
| Government | O |
| Comm-institutional | O |
| Industral | I |
| Solvent Evaporation | 1/2 I, 1/2 O |

*PP = power plants
I = industrial
O = other

## III. Justification of Growth Factors

It was somewhat arbitrarily assumed that personal automobile usage would grow at a rate of 3%/year, and commerce would grow at a rate of 4%/year. Thus the following growth rates were assumed:

LDV = 3%, as above.

LDT = 3.5%, reflecting the split of usage of LDT's between personal use and for business purposes.

Gas Handling = 3%, which assumed it will grow with personal usage of automobiles.

All other source categories = 4%, since trucking as well as stationary source growth can be expected to follow commerce's growth rates.

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16. Abstract

This Air Quality and Emissions Panel Report is No. 3 of a group of seven (7) prepared by special panels of the Task Force established under the joint chairmanship of DOT and EPA to conduct a study of the practicability of a fuel economy improvement standard of 20% for new motor vehicles produced in the 1980 time frame.

The report describes the factors which effect air quality, i.e., number and kind of stationary emission sources, the motor vehicle fleet mix and number of vehicle miles traveled by each class of vehicle, etc.; and then by using a simple methodology described in the test, draws some conculsions on the effect various fuel economy strategies will have on air quality.

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